Carnegie Mellon University

Rosie: Teleoperated Robot Worksystem

Technology Need:

Work tasks for deactivation of Department of Energy (DOE) facilities include equipment disassembly and dismantling; size reduction, packaging and removal of materials; decontamination of structures and building surfaces; and sensor surveys and mapping to assure reduction of contamination and regulatory compliance. To maintain "as low as reasonably achievable" (ALARA) standards and minimize worker exposure to radiation and other hazards, these tasks have to be performed with robots and other remote equipment to the maximum extent possible. To achieve acceptable levels of productivity and lowest possible cost, the robots need to model their environment so that automatic control techniques can be used to improve performance.

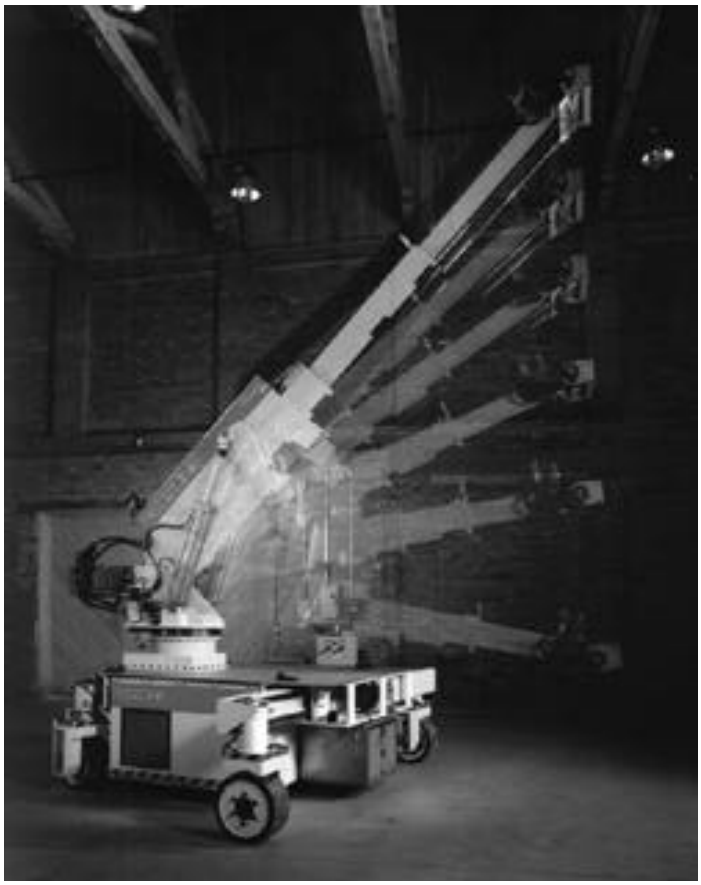
Technology Description:

The mobile worksystem Rosie provides all the necessary locomotion, heavy lifting and tooling deployment capabilities to perform D&D tasks remotely. Rosie is an electrohydraulic omni-directional locomotor with a four degree of freedom heavy manipulator mounted on its deck. The most important attribute of the Rosie mobile worksystem is its ability to address a variety of relevant D&D problems. Rosie deploys Oak Ridge National Laboratory's (ORNL's) Dual Arm Work Module (DAWM) as its primary payload and uses a variety of tooling for dismantlement operations..

The DAWM and other tools will be deployed by a high-reach telescoping boom capable of positioning 2000 lbs throughout a large work envelope (0 to 27 feet above floor level). The boom is mounted on an omni-directional wheeled locomotor, a configuration that is well-matched to the primarily flat floor world of DOE facilities. Rosie's coordinated controls, ergonomic user interface, and modular design simplify installation and operation of the worksystem.

Rosie is designed like a piece of construction equipment; it can withstand the rigors of heavy work over periods of years. Though initial worksystem and tooling configurations will address a wide variety of tasks, the design incorporates spare conductors, power, and controls for the addition of tooling to meet future challenges. Likewise its control system is adaptable to accommodate system changes and upgrades.

Robotic task performance can be improved if the geometry of the work area is known. However, blueprints and as-built drawings of most facilities do not exist. Therefore, CMU developed Artisan, a perception system



that combines range sensors and object analysis software to create a 3-D model of the robot's work area in situ (i.e, as it is discovered by the robot). Artisan uses laser rangefinder technology to generate a geometric description of objects in the robot's workspace exactly as they are found. This data can then be input to planning algorithms that sequence robot motions and enforce safeguards such as avoiding collisions. From the same information, a single display of the worksystem and the objects in its surroundings is generated, which the operator can view from any perspective. The display also provides a means for human/robot interaction through which the worksystem can be commanded.

The combination of workspace modeling and telerobotic control allow the operator to focus on task objectives rather than the details of remote equipment operation. Motion coordination, execution of trivial and low-risk actions and monitoring of system status are instead relegated to the computer control system with a net result of faster, safer task execution.

Benefits:

<Remote capabilities to operate tools, manipulate and package contaminated objects, and position sensors

<Dexterity combined with high strength throughout a large work volume

<Mobility to make the worksystem self-deploying and increase the work envelope beyond that of a fixed base

<Power and signal tether provides reliable communications and allows unlimited work duration

<Computer control for precise positioning, motion coordination, and status monitoring

<Workspace geometry modeling to enhance remote viewing, improve robot control, and improve speed of task execution

Status and Accomplishments:

Rosie was demonstrated and deployed at the Argonne National Laboratory as part of the CP-5 Large Scale Demonstration Project during June-September1997. Rosie removed approximately 3,000 lbs of contaminated graphite block and safely off-loaded 5,000 lbs of radioactive materials from the top of the CP-5 reactor without risking exposure to radiation by personnel. Rosie is currently being deployed (FY 2001) at ORNL's building K-1420. The system will be available for future deployment after completion of this D&D work.

Based on Artisan, a modified system was built and delivered to Argonne National Laboratory (ANL) for CP-5 D&D work under D&D Focus Area Sponsorship.

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Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 1799
http://ost.em.doe.gov/tms

The National Energy Technology Laboratory Internet address is **http://www.netl.doe.gov**

The Carnegie Mellon University Internet address is **http://www.cmu.edu/**

An Innovative Technology Summary Report, DOE/EM-0429 for this technology is located at **http://ost.em.doe.gov/ifd/ddfa/itsr1799/itsr1799.pdf**